

## CLAIMS

What is claimed is:

- 1 1. A method of applying steerable filter to Laplacian images of a steerable
- 2 pyramid, comprising:
  - 3 getting a Laplacian image from corresponding Gaussian images in a
  - 4 steerable
  - 5 pyramid;
  - 6 verifying the Laplacian image for negative value;
  - 7 adjusting the Laplacian image to eliminate the negative value;
  - 8 applying a steerable filter to the adjusted Laplacian image to generate
  - 9 orientation data and energy data ; and
  - 10 removing resulting adjustment
- 1 2. The method of claim 1 further comprising generating image descriptors
- 2 from the orientation data and the energy data.
- 1 3. The method of claim 1 wherein getting the Laplacian image comprises
- 2 subtracting the two neighboring Gaussian images.
- 1 4. The method of claim 1 wherein verifying comprises measuring intensity
- 2 value of the Laplacian image.
- 1 5. The method of claim 1 wherein adjusting comprises adding a constant
- 2 factor to the Laplacian image such that when the steerable filter is

3 applied to the adjusted Laplacian image, the resulting orientation map  
4 and energy map are not negative.

1 6. The method of claim 1 wherein removing resulting adjustment comprises  
2 compensating for a spatial shift to the energy data, the spatial shift  
3 resulting from the adjustment added to the Laplacian image.

1 7. A method of filtering images, comprising:  
2 constructing a plurality of orientation maps and a plurality of energy  
3 maps from input images, the input images adjusted by a factor  
4 prior to applying filters, the adjustment factor being such that  
5 the plurality of orientation maps and the plurality of energy  
6 maps are non-negative; and  
7 removing resulting adjustment factors from the plurality of energy  
8 maps.

1 8. The method of claim 7 wherein the input images are Laplacian images,  
2 the Laplacian images constructed by subtracting two corresponding  
3 Gaussian images in a steerable pyramid.

1 9. The method of claim 7 wherein the filters are steerable filters.

1 10. The method of claim 7 wherein the adjustment is made to the intensity  
2 value of the Laplacian images.

1 11. The method of claim 7 further comprising constructing image descriptors  
2 for the Laplacian images, the image descriptors constructed from the

3 corresponding orientation maps and energy maps, the energy maps  
4 having had the corresponding resulting adjustment factors compensated.

1 12. In a steerable pyramid, a method of adjusting images prior to filtering,  
2 comprising:

3 Filtering an input image at a first time to produce a corresponding  
4 orientation

5 map and a corresponding energy map;

6 Adjusting the input image by an adjustment factor if the orientation  
7 map

8 and / or the energy map is negative, the adjustment factor  
9 being such that when the adjusted input image is filtered, the  
10 orientation map

11 and / or the energy map is non-negative; and

12 Filtering the adjusted input image at a second time.

1 13. The method of claim 12, wherein the filtering is done by applying  
2 steerable filters and wherein the input image is a Laplacian image in a  
3 steerable pyramid.

1 14. The method of claim 12, wherein adjusting the input image by an  
2 adjustment factor comprises determining the value of the Laplacian  
3 image, and adding the adjustment factor such that the value of the  
4 Laplacian image is non-negative.

1 15. The method of claim 12 wherein the intensity value is the value of the  
2 Laplacian image.

1       16. A computer readable medium containing executable instructions which,  
2       when executed in a processing system, causes the system to perform the  
3       steps for filtering images, comprising:

4           getting a Laplacian image from corresponding Gaussian images in a  
5       steerable

6                   pyramid;

7           verifying the Laplacian image for negative value;

8           adjusting the Laplacian image to eliminate the negative value;

9           applying a steerable filter to the adjusted Laplacian image to generate  
10                   orientation data and energy data ; and

11           removing resulting adjustment.

1       17. The computer readable medium of claim 16 further comprising  
2       generating image descriptors from the orientation data and the energy  
3       data.

1       18. The computer readable medium of claim 16, wherein getting the  
2       Laplacian image comprises subtracting the two neighboring Gaussian  
3       images.

1       19. The computer readable medium of claim 16, wherein verifying comprises  
2       measuring intensity value of the Laplacian image.

1       20. The computer readable medium of claim 16, wherein adjusting comprises  
2       adding a constant factor to the Laplacian image such that when the

3       steerable filter is applied to the adjusted Laplacian image, the resulting  
4       orientation map and energy map are not negative.

1       21. The computer readable medium of claim 16, wherein removing resulting  
2       adjustment comprises compensating the resulting adjustment factor from  
3       the energy map, the resulting adjustment factor corresponding to the  
4       adjustment added to the Laplacian image.

1       22. An apparatus, comprising:  
2           means for filtering input images to produce corresponding  
3           orientation maps  
4           and energy maps; and  
5           means for adjusting the input images such that the corresponding  
6           orientation maps and / or energy maps are non-negative.

1       23. The apparatus of claim 22, wherein means for filtering input images  
2       comprises means for generating Gaussian images from an original image  
3       and means for generating Laplacian images from the Gaussian images,  
4       and wherein steerable filters are used in filtering the Laplacian images.

1       24. The apparatus of claim 22, wherein means for adjusting the input images  
2       comprises means for calculating intensity value of the Laplacian images  
3       and means for adding an adjustment factor to the Laplacian images such  
4       that the intensity value is non-negative.

- 1 25. A method comprising:
  - 2 filtering input images to produce corresponding orientation maps and
  - 3 energy maps; and
  - 4 adjusting the input images such that the corresponding orientation maps
  - 5 and / or energy maps are non-negative.
- 1 26. The method of claim 25, wherein filtering input images comprises:
  - 2 generating Gaussian images from an original image;
  - 3 generating Laplacian images from the Gaussian images; and
  - 4 filtering the Laplacian images by using steerable filters.
- 1 27. The method of claim 25, wherein adjusting the input images comprises:
  - 2 calculating intensity value of the Laplacian images; and
  - 3 adding an adjustment factor to the Laplacian images such that the
  - 4 intensity value is non-negative.
- 1 28. A computer system comprising:
  - 2 a processor; and
  - 3 an image processing logic coupled to the processor, comprising
  - 4 generation logic to form Gaussian images from an original
  - 5 image and to form a Laplacian image from the
  - 6 corresponding two Gaussian images,
  - 7 adjustment logic to add a value to the Laplacian image such
  - 8 that the Laplacian image is non-negative, and
  - 9 logic to apply a steerable filter to the adjusted Laplacian image
  - 10 to produce an energy map and an orientation map.

- 1 29. The computer system of claim 28 further comprising logic to compensate
- 2 for partial shift to the energy map, the partial shift resulting from the
- 3 corresponding adjustment made to the Laplacian image.
  
- 1 30. The computer system of claim 28 wherein the Gaussian images and the
- 2 Laplacian images are in a steerable pyramid, and wherein the value of
- 3 the Laplacian image is measured by its intensity.
  
- 1 31. The computer system of claim 28 further comprising logic to form image
- 2 descriptors using the orientation map and the energy map.